Air Force Civil Engineer Center

Integrity - Service - Excellence

FORMER
WILLIAMS AIR FORCE BASE

Site ST012
Former Liquid Fuels Storage Area Remedial Action

BCT Conference Call
18 February 2016

Site ST012 Update

- Steam Enhanced Extraction (SEE) Operations Progress
- Near-term SEE Operational Plan
- Review of Transition Criteria
- EPA comments on EBR RD/RAWP Addendum #2

SEE System Operational Status Overview

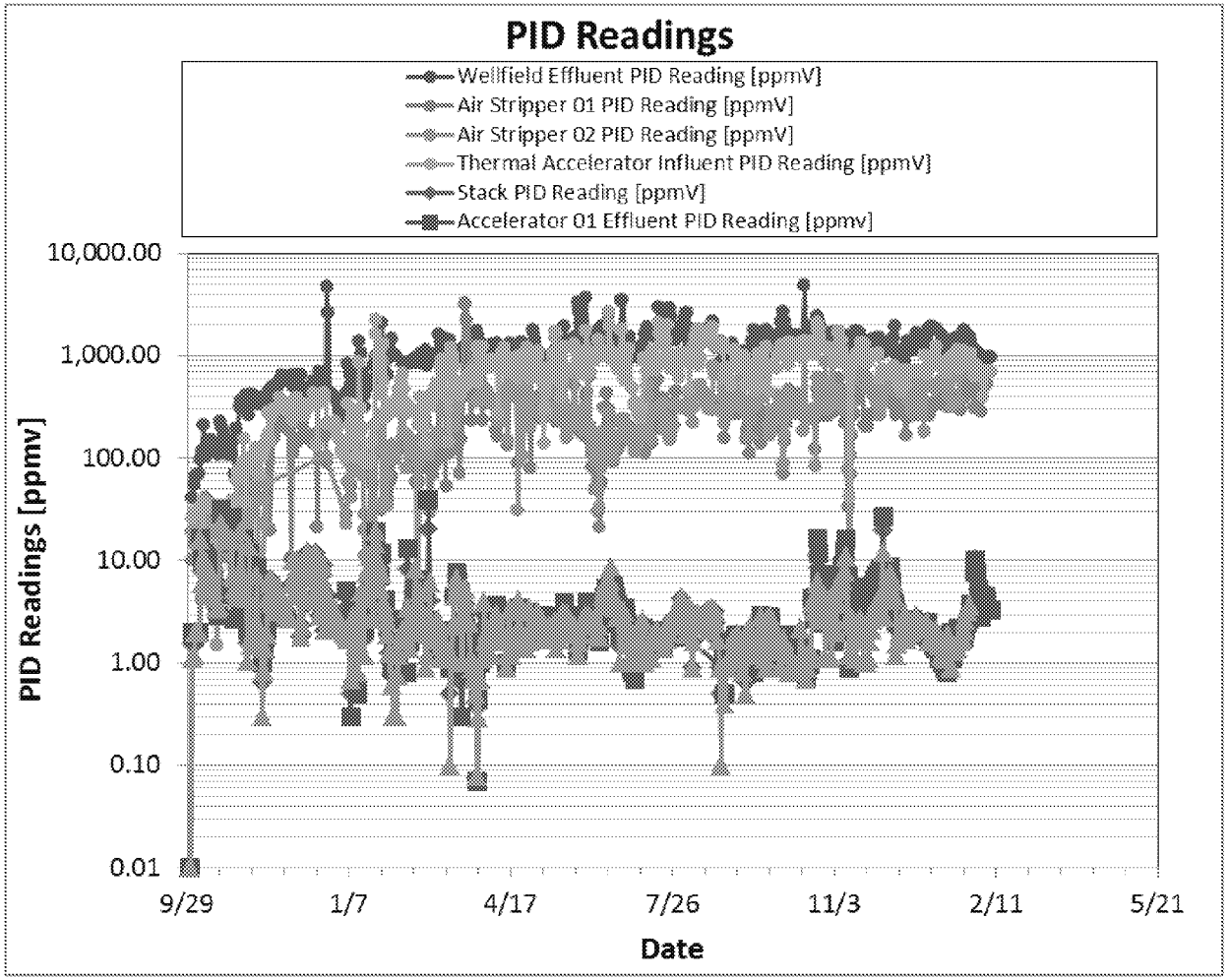
Site ST012 SEE System Status Summary (through 8 February)

	Value	Unit
Target Treatment Zone (TTZ) Soil Volume	410,000	cubic yards (cy)
Area	199,000	square feet (ft^2)
Upper Depth of Treatment	145	feet (ft) below ground surface (bgs)
Lower Depth of Treatment	245	ft bgs
Vapor Liquid Treatment Started	09/29/14	
Thermal Operations Started	09/29/14	
Last Process Data Update	02/08/16	
Last Temperature Data Update	02/08/16	
Estimated Total Days of Operation	422	days
Days of Operation	497	days
Days of Operation vs. Estimate	118	percent (%)
Estimated Total Energy Usage	11,343,000	kilowatt hours (kWh)
Total Energy Used	5,108,413	kWh
Used Electrical Energy vs. Estimate	45	%
Total Steam Injected	296.6	million pounds (lbs)
Projected Total Steam Injection	320	million lbs
Steam Injected Vs Projected	93	%
Total Mass Removed in Vapor Based on Photoionization Detector (PID) Readings	1,058,165	lbs
Total Mass Removed as NAPL	1,315,721	lbs
Average Daily NAPL Mass Removal Last Week	0	lbs/day
Total Vapor and Liquid Mass Removal (based on PID readings)	2,373,886	lbs
Average Power Usage Rate Last Week	466	kilowatts (kW)
Average Wellfield Vapor Extraction Rate Last	537	standard cubic feet per minute (scfm)
Average Condensate Production Rate Last Week	1.2	gallons per minute (gpm)
Average Water Extraction Rate Last Week	111	gpm
Total Water Extracted	78,944,065	gallons
Total Recovered Light Non-Aqueous Phase Liquid	200,262	gallons
Average Water Discharge Rate Last Week	139	gpm
Total Treated Water Discharge	105,573,000	gallons

ST012 SEE Operational Progress

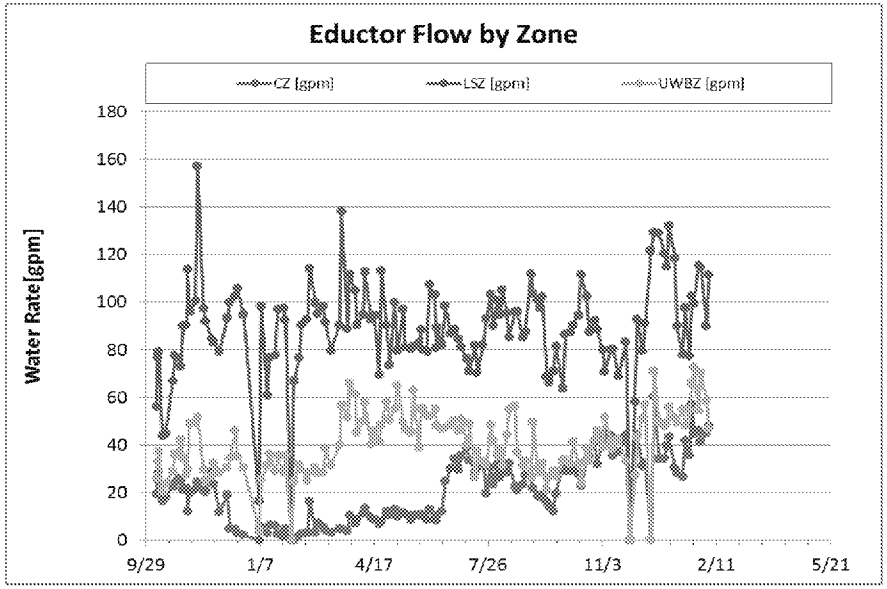
- **SEE System Operations 19 January – 8 February**
  - A site-wide pressurization began 21 January 2016. A site-wide depressurization was initiated 05 February 2016.
  - Average liquid extraction rate of 136 gpm
  - Typically six eductor skids were online at a time
  - Average steam injection rates of 4,800 lbs per hour in the LSZ, 10,300 lbs per hour in the UWBZ, and 6,700 lbs per hour in the CZ
  - Thirty-two steam wells online – injection rates at wells have varied due to pressure cycling conducted in the CZ, LSZ and UWBZ
  - On 04 February 2016 laboratory results for 18 January 2016 samples were received that indicated the discharge benzene concentration (130 µg/L) exceed the permit limit (35 µg/L). The City of Mesa was notified and investigation of causes/solutions was initiated.

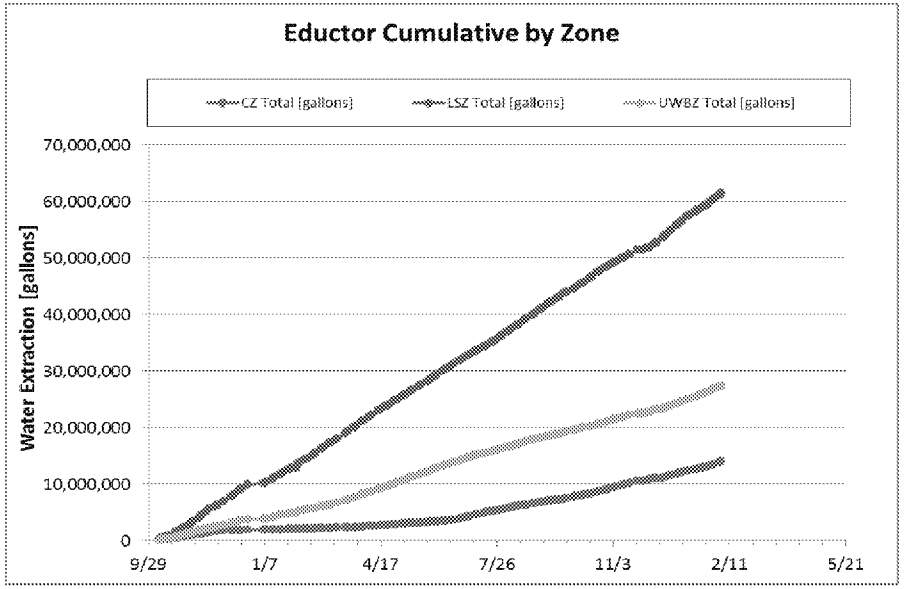
Site ST012 SEE System Photoionization Detector (PID) Readings



Vapors continue to be rich in organics

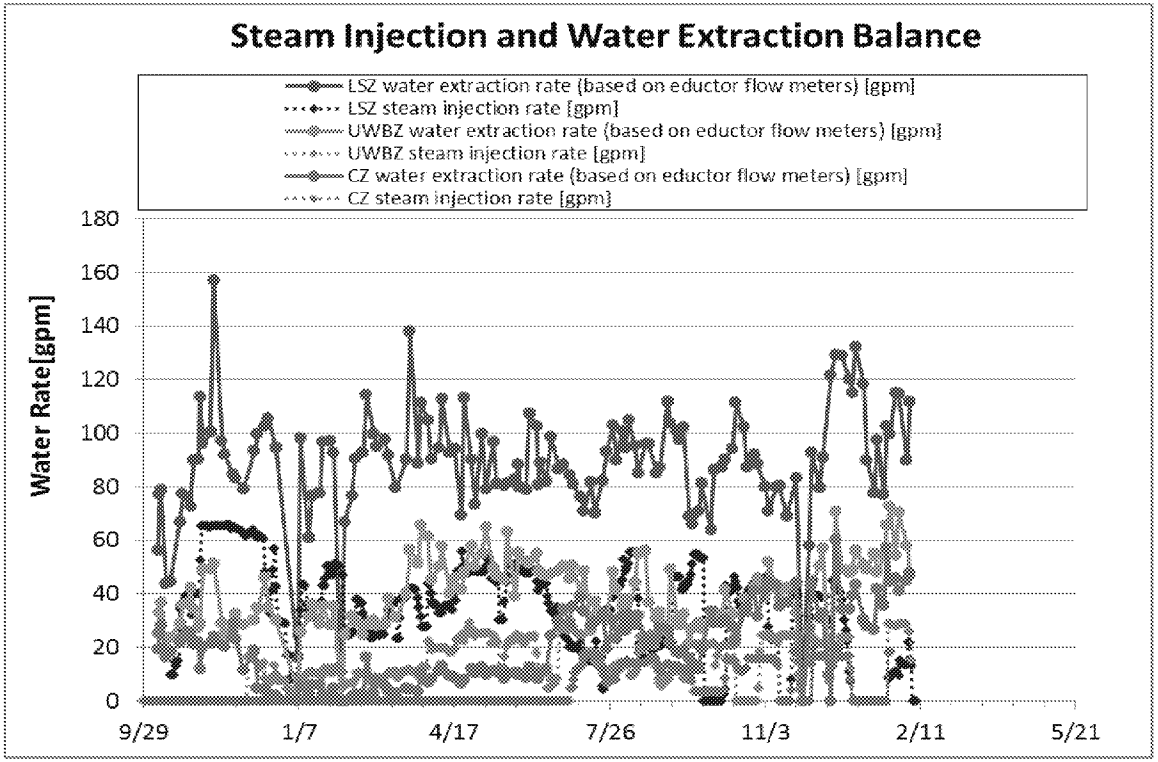
Site ST012 SEE System Water Extraction by Zone





- **Eductor extraction rates per zone are based on individual eductor feed and return meters**
- **Extraction: injection ratio for the period 19 January to 08 February based on average flows**
  - **CZ: 19 January 2015 – 8 February 2016 period: 2.7:1**
  - **UWBZ: 19 January 2015 – 8 February 2016 period: 2.4:1**
  - **LSZ: 19 January 2015 – 8 February 2016 period: 8.6:1**

Site ST012 SEE System Injection/Extraction Balance

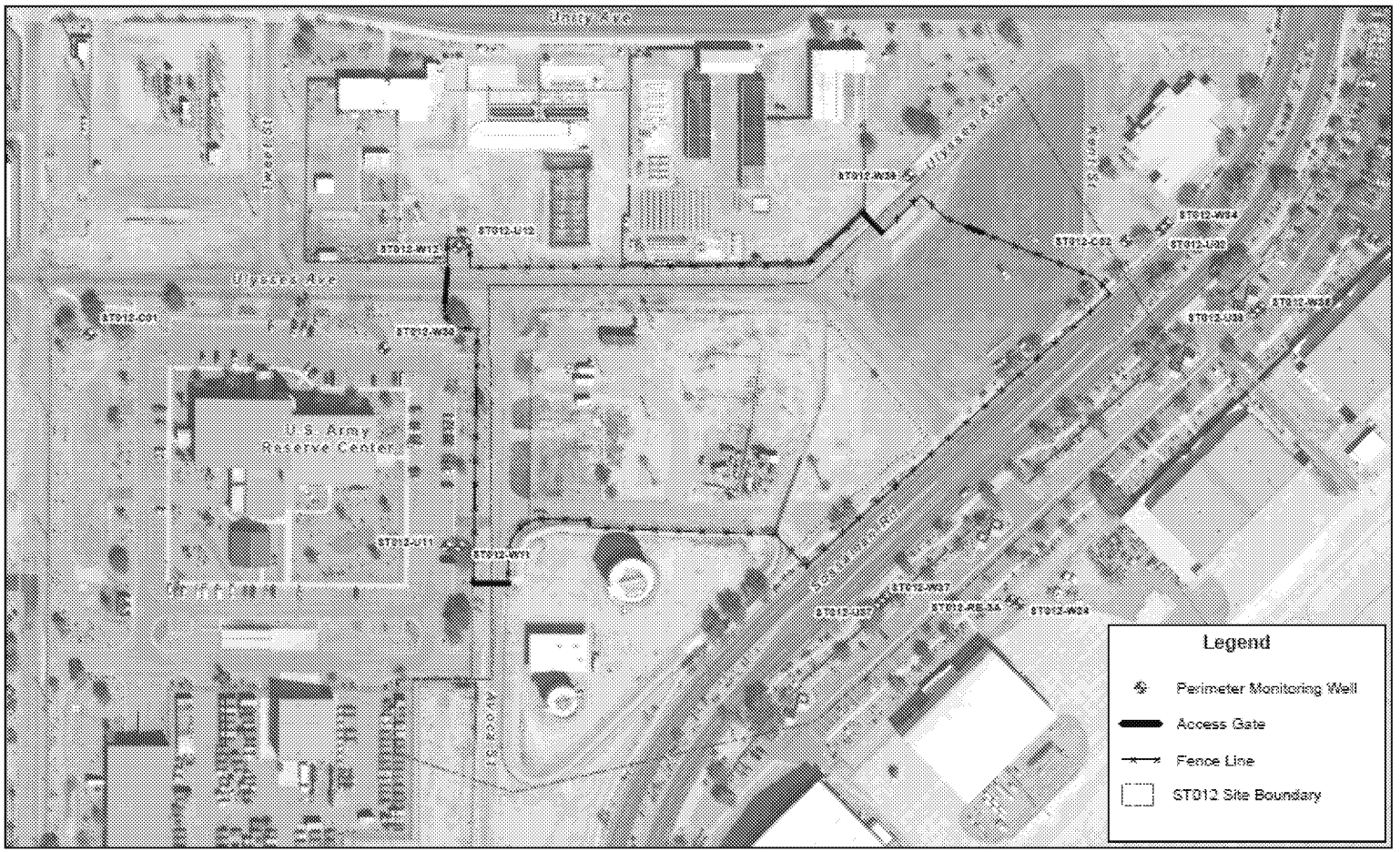


	CZ [gallons]	UWBZ [gallons]	LSZ [gallons]
Water extracted to date	14,022,000	27,363,000	61,448,000
Water injected to date	3,498,000	9,081,000	23,042,000
Net extraction	10,524,000	18,282,000	38,406,000

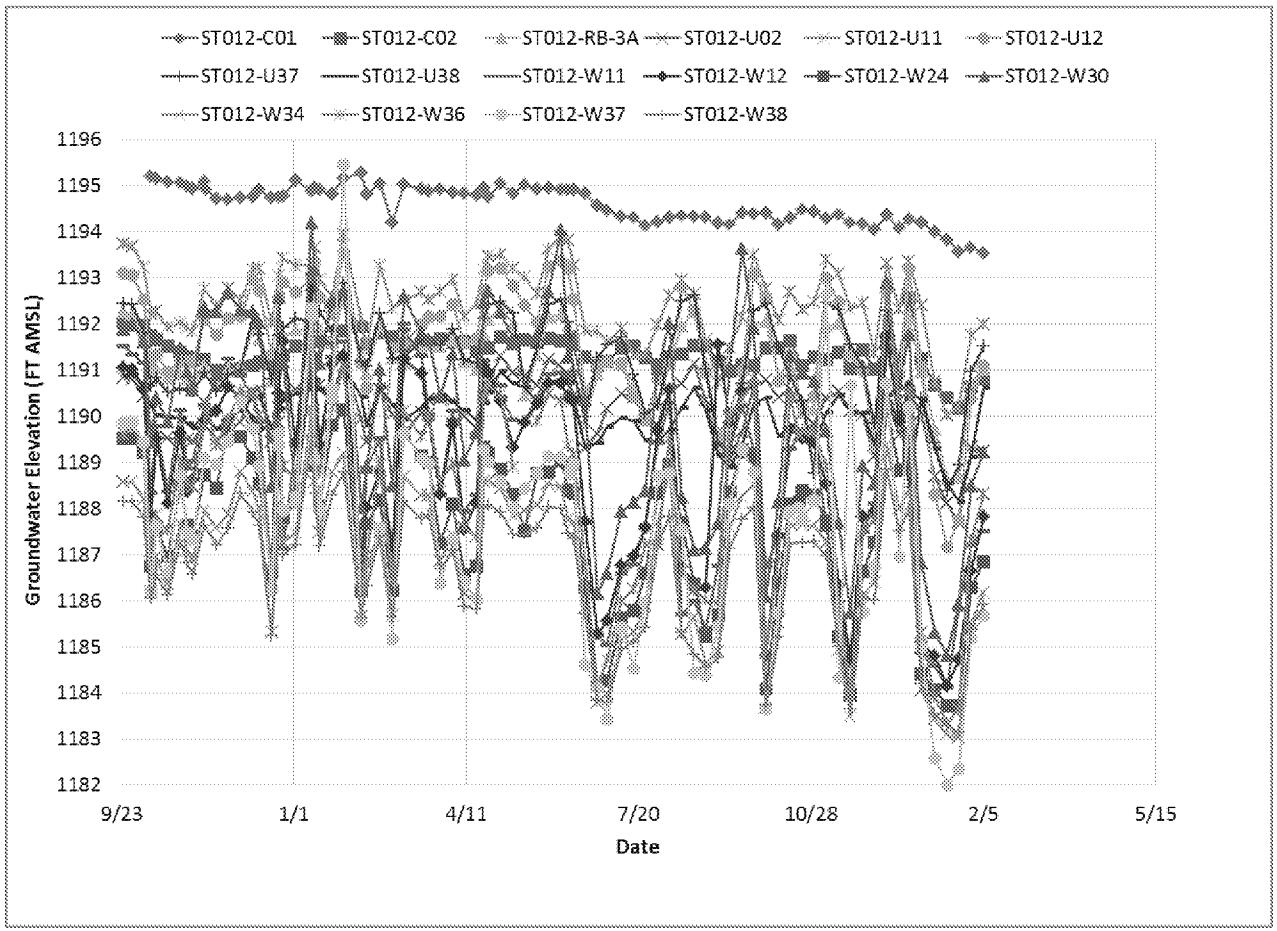
Note: water extracted to date per zone is based on individual eductor meters

ST012 Perimeter Groundwater Monitoring

Site ST012 SEE Perimeter Groundwater Monitoring Wells



Site ST012 SEE Perimeter Groundwater Elevations



Water level increases are temporary

Site ST012 SEE Perimeter LNAPL Thicknesses (ft)

Monitoring Well	1/15/2016		1/22/2016		1/29/2016		2/5/2016	
CZ/UWBZ Wells	Before bailing	After Bailing	Before bailing	After Bailing	Before bailing	After Bailing	Before bailing	After Bailing
ST012-C01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ST012-C02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UWBZ Wells								
ST012-U02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ST012-U11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ST012-U12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ST012-U37	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ST012-U38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ST012-RB-3A	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
LSZ Wells								
ST012-W11	5.01	5.01	0.00	0.00	5.51	5.51	5.49	5.49
ST012-W12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ST012-W24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ST012-W30	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
ST012-W34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ST012-W36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ST012-W37	72.21	27.13	27.54	17.04	43.97	4.26	30.87	5.62
ST012-W38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

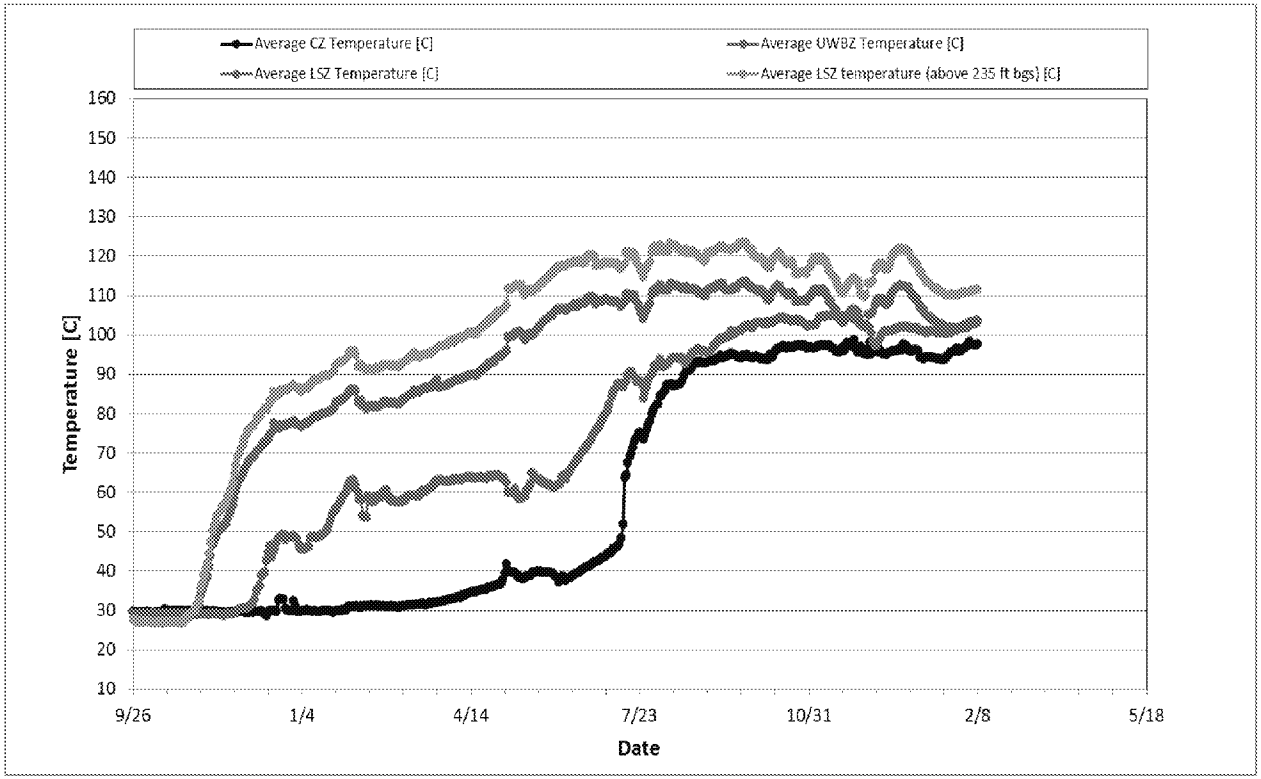
ST012 SEE to EBR Transition

Site ST012 SEE System
SEE to EBR Transition Criteria

- Criteria established to evaluate when the effectiveness of contaminant mass removal by SEE has diminished:
  - Primary SEE to EBR Transition Criteria
    - Achieve target subsurface temperatures
    - Diminishing mass removal rates
  - Secondary SEE to EBR Transition Criteria
    - Completion of Pressure Cycling: Repeat until no additional significant increases in effluent vapor concentrations observed when steam pressure is reduced
    - Benzene Concentrations: Target benzene concentration of 100 to 500 µg/L range within the TTZ (interior of the TTZ)
    - Steam Injection: Used as a guideline to measure progress vs. design
- Criteria are based on principal of multiple lines of evidence. The criteria will be considered in total with the weight of evidence from these multiple lines being used for decisions. Individual compliance with each criteria is not absolute.

Subsurface Temperatures and Steam Breakthrough

Site ST012 SEE
Average Temperatures by Zone



- **Site-wide pressurization initiated on 21 January 2016**
- **Site-wide depressurization initiated on 05 February 2016**

CZ Target Treatment Temperature: ~100°C
UWBZ Target Treatment Temperature: ~114°C
LSZ Target Treatment Temperature: ~134°C

Site ST012 SEE TMP Maximum Depth-Averaged Temperature by Zone

Temperature Monitoring Point	Temperature Monitoring Point Maximum Depth-Averaged Temperature[1] (°C) During SEE Operations by Zone				
	CZ	UWBZ	LPZ	LSZ	LSZ (depths above 235 ft bgs)
TMP01	114.9	130.5	N/A	N/A	N/A
TMP03	N/A	N/A	137.5	114.2	120.7
TMP04	N/A	N/A	103.8	118.8	127.1
TMP05	110.3	N/A	N/A	N/A	N/A
TMP06	N/A	N/A	137.4	135.0	135.9
TMP07	N/A	N/A	134.6	137.2	140.2
TMP08	N/A	N/A	136.6	131.3	135.4
TMP09	N/A	N/A	132.5	134.1	139.3
TMP11	N/A	N/A	110.6	119.1	131.7
TMP12	75.7	91.3	121.8	121.4	131.3
TMP13	102.1	119.8	130.6	138.4	140.0
TMP14	N/A	N/A	133.6	124.3	136.3
TMP15	113.1	123.3	128.7	126.5	135.6
TMP16	N/A	N/A	126.7	120.5	131.0
TMP17	N/A	N/A	135.2	136.9	136.9
Maximum depth-averaged by zone[2]	**103.2**	**116.2**	**128.4**	**127.5**	**134.0**

If N/A, Temperature Monitoring Point has no sensors in that zone

[1] Temperature of the thermocouples across each depth zone are averaged for each TMP and each available time interval and then the maximum value of those averages throughout operations is listed in the table.

[2] Average of maximum depth-averages listed above for all TMPs in each zone.

- **Target treatment temperatures achieved in all zones (LSZ <235 ft bgs average is 134°C)**

CZ Target Treatment Temperature: ~100°C
UWBZ Target Treatment Temperature: ~114°C
LSZ Target Treatment Temperature: ~134°C

Site ST012 SEE
MPE Steam Breakthrough Achievement

Well	Well	Required to Reach	Steam Breakthrough Achieved at MPE
	Location	Steam Temperature	Temperature Calculated
CZ07	Perimeter	No	No
CZ08	Perimeter	No	No
CZ09	Perimeter	No	No
CZ10	Perimeter	No	Yes
CZ11	Interior	Yes	Yes
CZ12	Perimeter	No	Yes
CZ13	Perimeter	No	Yes
CZ14	Perimeter	No	Yes
CZ15	Interior	Yes	Yes
CZ16	Perimeter	No	Yes
CZ17	Perimeter	No	Yes
CZ18	Perimeter	No	No
CZ19	Perimeter	No	No
CZ20	Outside CZ	No	No

Well	Well	Required to Reach	Steam Breakthrough Achieved at MPE
	Location	Steam Temperature	Temperature Calculated
UWBZ01	Interior	Yes	Yes
UWBZ02	Interior	Yes	Yes
UWBZ04	Interior	Yes	Yes
UWBZ05	Interior	Yes	Yes
UWBZ06	Interior	Yes	Yes
UWBZ10	Perimeter	No	Yes
UWBZ17	Perimeter	No	Yes
UWBZ18	Interior	Yes	Yes
UWBZ19	Perimeter	No	Yes
UWBZ20	Dual Phase - Perimeter	No	No
UWBZ21	Outside UWBZ	No	No
UWBZ22	Perimeter	No	No
UWBZ23	Outside UWBZ	No	Yes
UWBZ24	Dual Phase - Perimeter	No	No
UWBZ26	Outside UWBZ	No	No
UWBZ27	Outside UWBZ	No	Yes

Well	Well	Required to Reach	Steam Breakthrough Achieved at MPE
	Location	Steam Temperature	Temperature Calculated
LSZ01	Interior	Yes	Yes
LSZ02	Interior	Yes	Yes
LZS04	Interior	Yes	Yes
LSZ05	Interior	Yes	Yes
LSZ06	Interior	Yes	Yes
LSZ08	Perimeter	No	Yes
LSZ11	Perimeter	No	Yes
LSZ12	Perimeter	No	No
LSZ13	Interior	Yes	Yes
LSZ14	Perimeter	No	No
LSZ15	Interior	Yes	Yes
LSZ16	Interior	Yes	Yes
LSZ17	Perimeter	No	Yes
LSZ28	Perimeter	No	Yes
LSZ29	Perimeter	No	No
LSZ30	Interior	Yes	Yes
LSZ31	Interior	Yes	Yes
LSZ32	Interior	Yes	Yes
LSZ33	Perimeter	No	Yes
LSZ34	Interior	Yes	Yes
LSZ35	Perimeter	No	Yes
LSZ36	Perimeter	No	Yes
LSZ37	Perimeter	No	Yes
LSZ38	Perimeter	No	Yes
LSZ39	Perimeter	No	No
LSZ40	Interior	Yes	Yes
LSZ42	Perimeter	No	Yes

- **Steam breakthrough has been achieved at all interior MPE wells**

Pressure Cycling and Mass Removal

Pressure Cycling Status

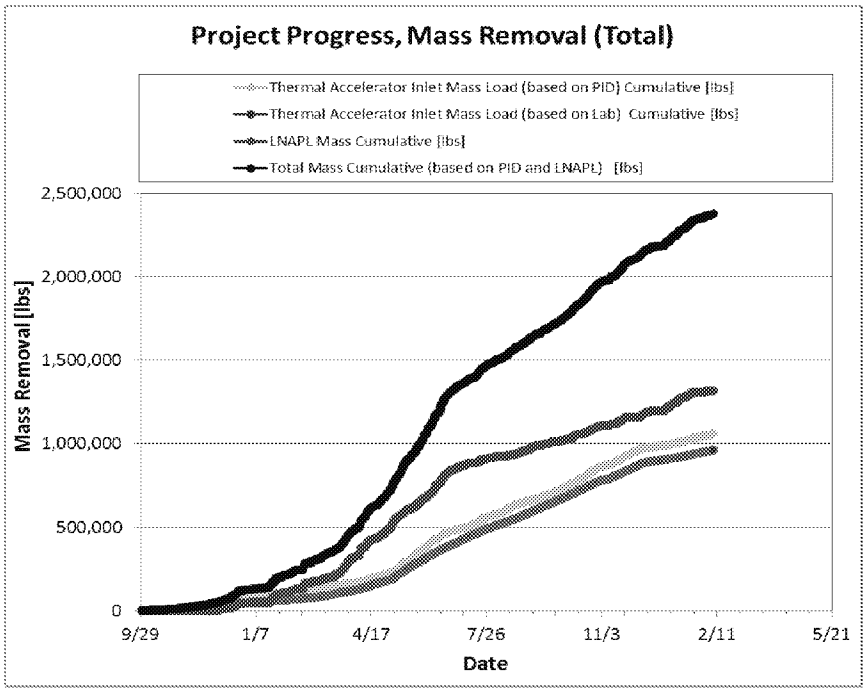
- **Operational data reviewed to determine initiation of pressure cycling:**
  - **Multi-phase Extraction (MPE) Well Vapor Extraction Temperature**
  - **Temperature Monitoring Point Data**
  - **Calculated MPE Well Formation Temperature**
  - **Pressure cycling initiated to enhance benzene removal and to limit potential NAPL migration outside the TTZ**
  - **Pressure cycling status reviewed on 27 May 2015 BCT call prior to initiation and again on 24 June 2015 BCT call after it was initiated in the northern portion of the UWBZ**
  - **Pressure cycling status reviewed monthly on BCT calls**
  - **Pressure cycling currently synchronized in all zones**

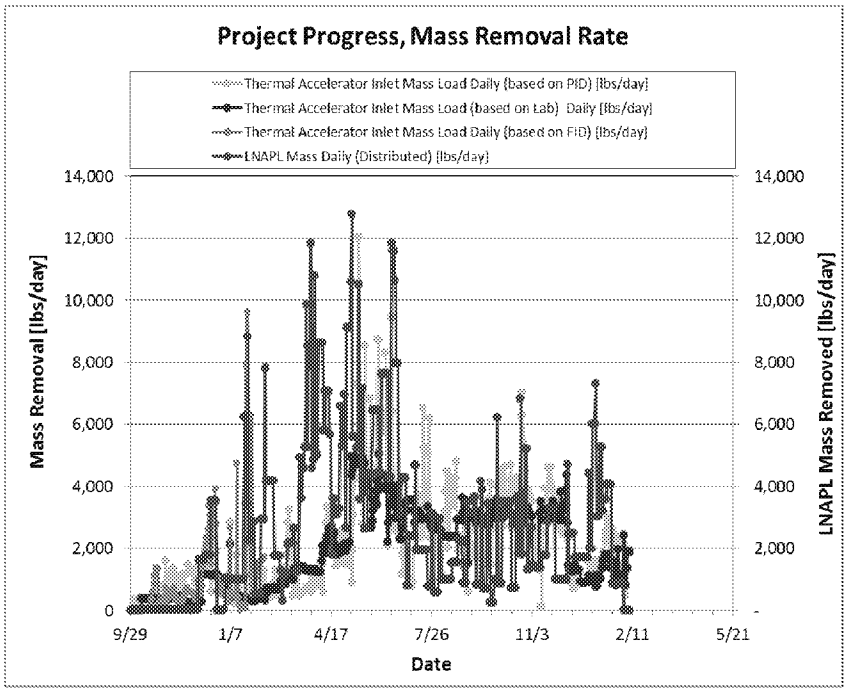
Pressure Cycling Status by Zone:

	Pressurization or Depressurization Initiation Dates																						# Cycles Completed
CZ						6/30/15				9/17/15		10/7/15			11/11/15	11/20/15	11/25/15	12/3/15	12/28/15	1/21/16	2/5/16	5
UWBZ		12/4/14	6/8/15		6/22/15		7/24/15	8/12/15	8/26/15	9/17/15			10/14/15	10/30/15			11/25/15	12/3/15	12/28/15	1/21/16	2/5/16	7
LSZ	10/16/14			6/16/15			7/24/15	8/12/15	9/4/15		9/25/15	10/7/15			11/11/15	11/20/15	11/25/15	12/3/15	12/27/15	1/21/16	2/5/16	7

Pressurization
Depressurization

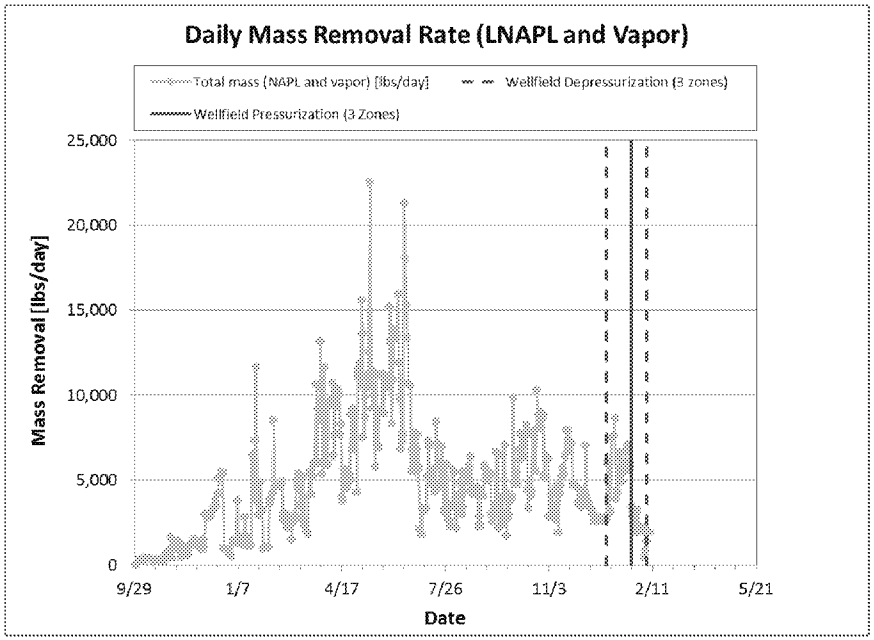
Site ST012 SEE System Mass Removal

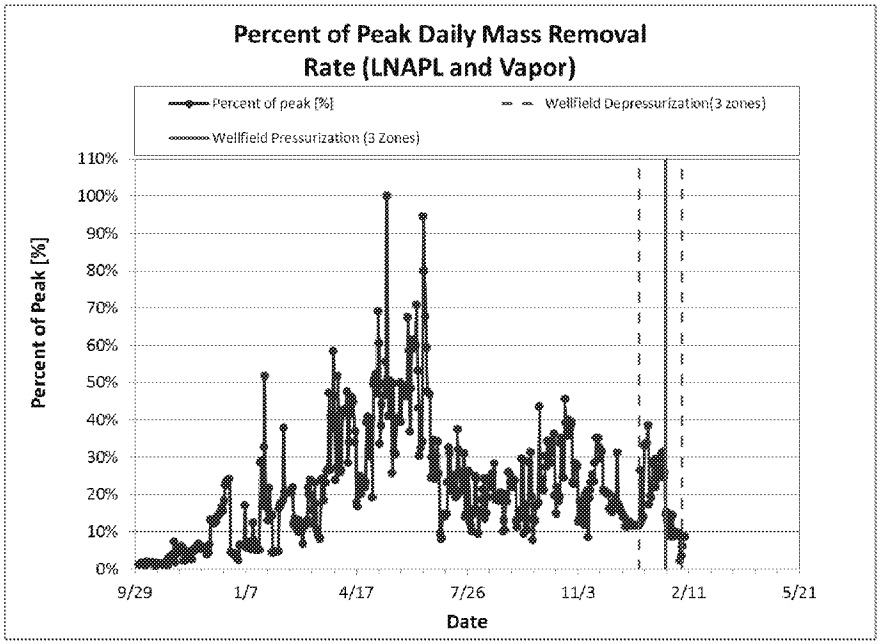




- **Total Contaminant Mass Removal: 2,373,886 lbs recovered**
- **An estimated 1,315,721 lbs (200,262 gallons) as non-aqueous phase liquid (NAPL)**
- **An estimated 1,058,165 lbs of mass (PID) removed in the vapor phase**

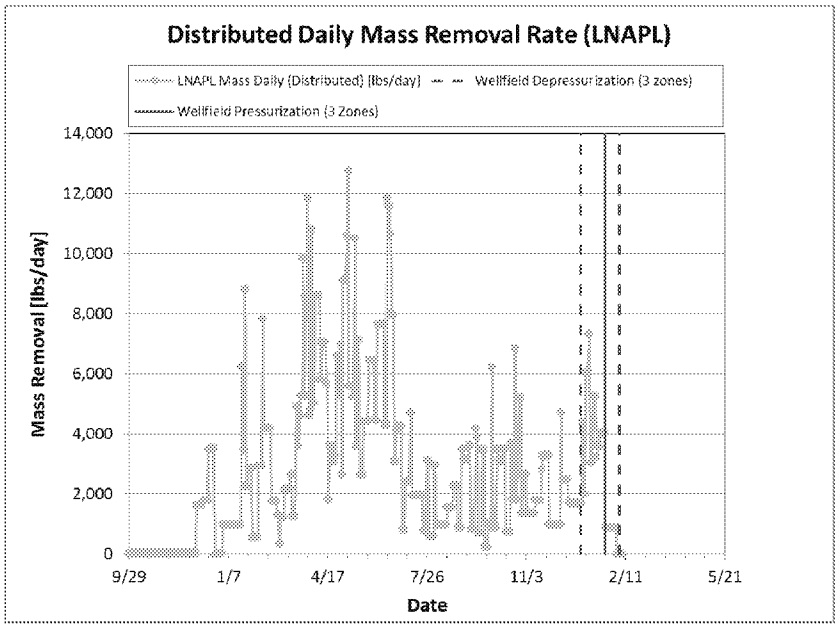
Site ST012 SEE System Daily Mass Removal

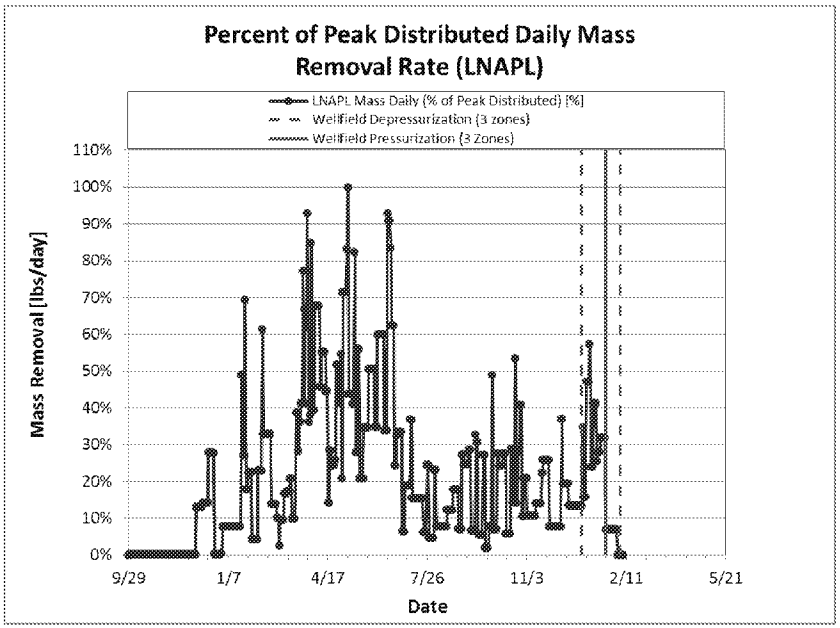




- Mass removal target of ~10% of peak is appropriate for ST012 because of the follow-on EBR and natural attenuation planned
- Mass removal peaked on 14 May 2015 at 22,506 lbs/day
- Mass recovery is 11% of peak on average from 19 January to 08 February 2016 (2,525 lbs/day)
- Mass recovery was 20 to 40% of peak in the previous site-wide depressurization
- Mass recovery is <5% of peak at end of most recent pressurization

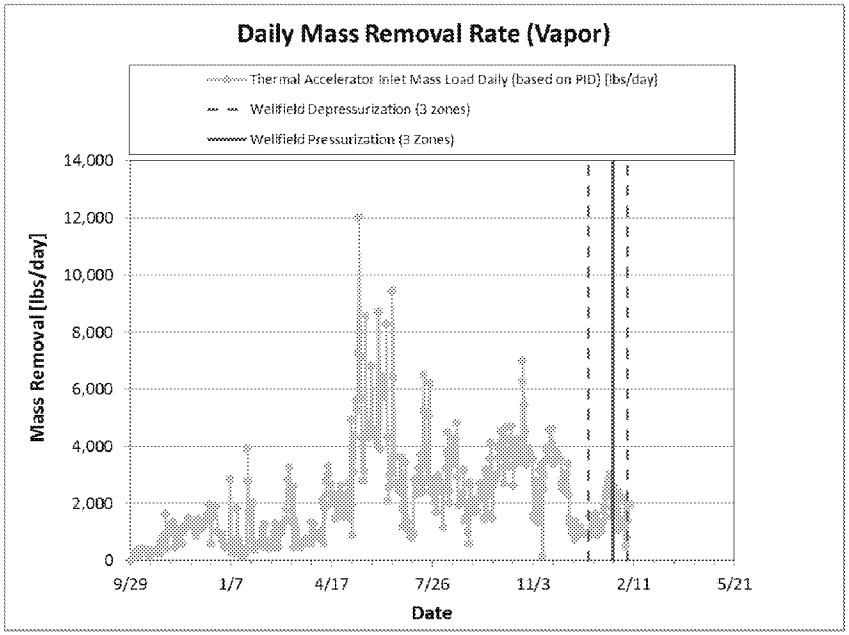
Site ST012 SEE System
Daily Mass Removal

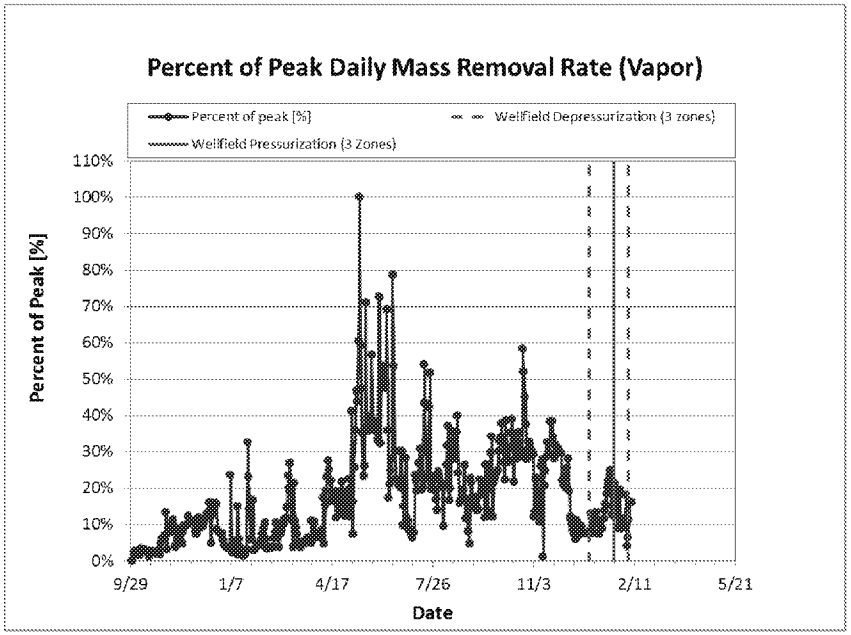




- **Daily LNAPL mass removal peaked on 05 May 2015 at 12,760 lbs/day**
- **Increase in overall mass removal during the site-wide depressurization predominately due to increase in LNAPL recovery.**
- **LNAPL recovery is 7% of the peak on average for 19 January to 08 of February 2016 (889 lbs/day)**
- **LNAPL recovery was 20-60% of peak in the previous site-wide depressurization**
- **LNAPL recovery is 0% of the peak at end of most recent pressurization**

Site ST012 SEE System
Daily Mass Removal

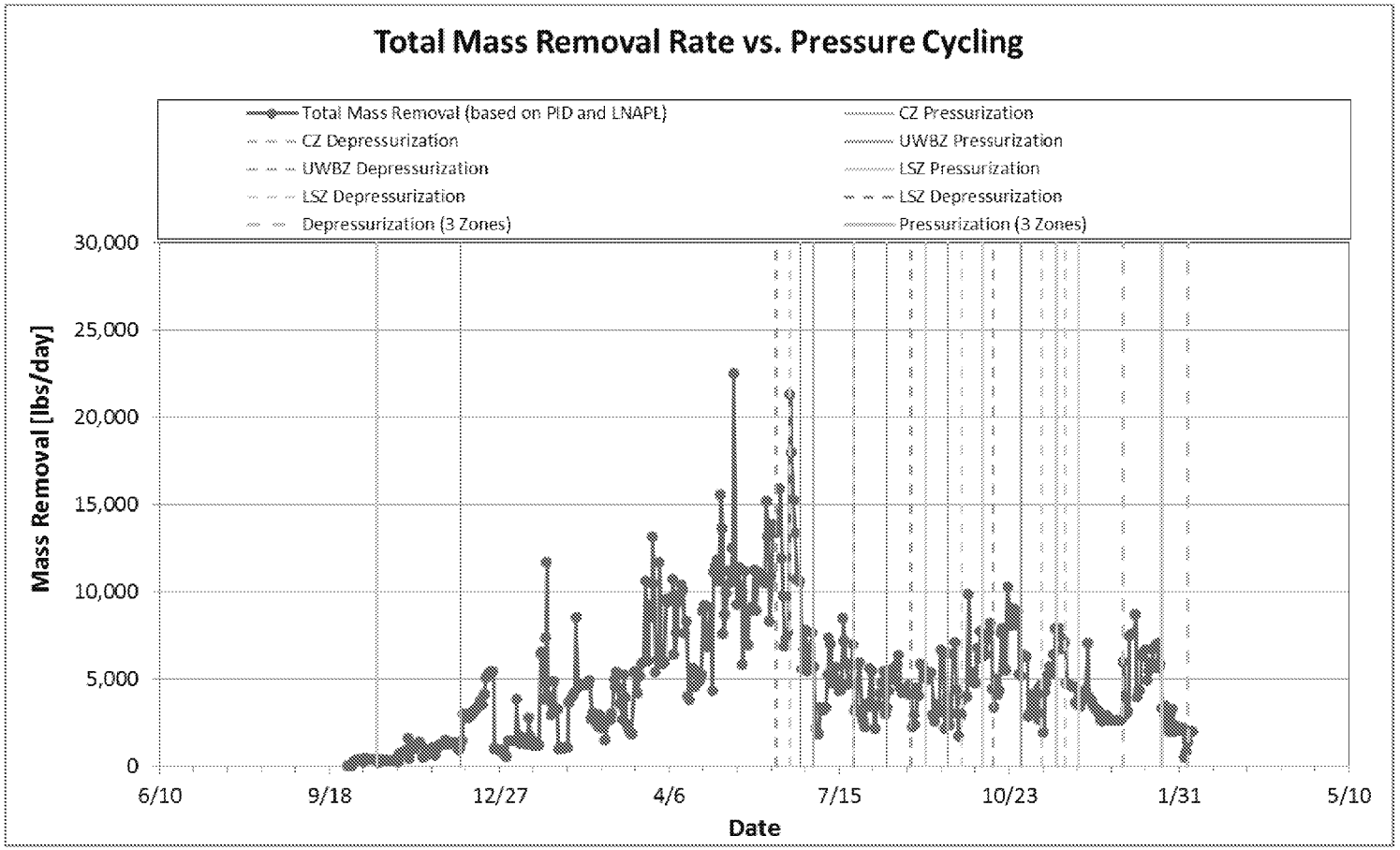




- Daily vapor mass removal peaked on 14 May 2015 at 12,009 lbs/day
- Vapor mass removal rates are 14% of the peak on average from 19 January to 08 February 2016 (1,636 lbs/day)
- Vapor mass removal was 10-20% of peak in the previous site-wide depressurization
- Vapor mass removal rates are 5% of the peak at end of most recent pressurization

Pressure Cycling and Mass Removal

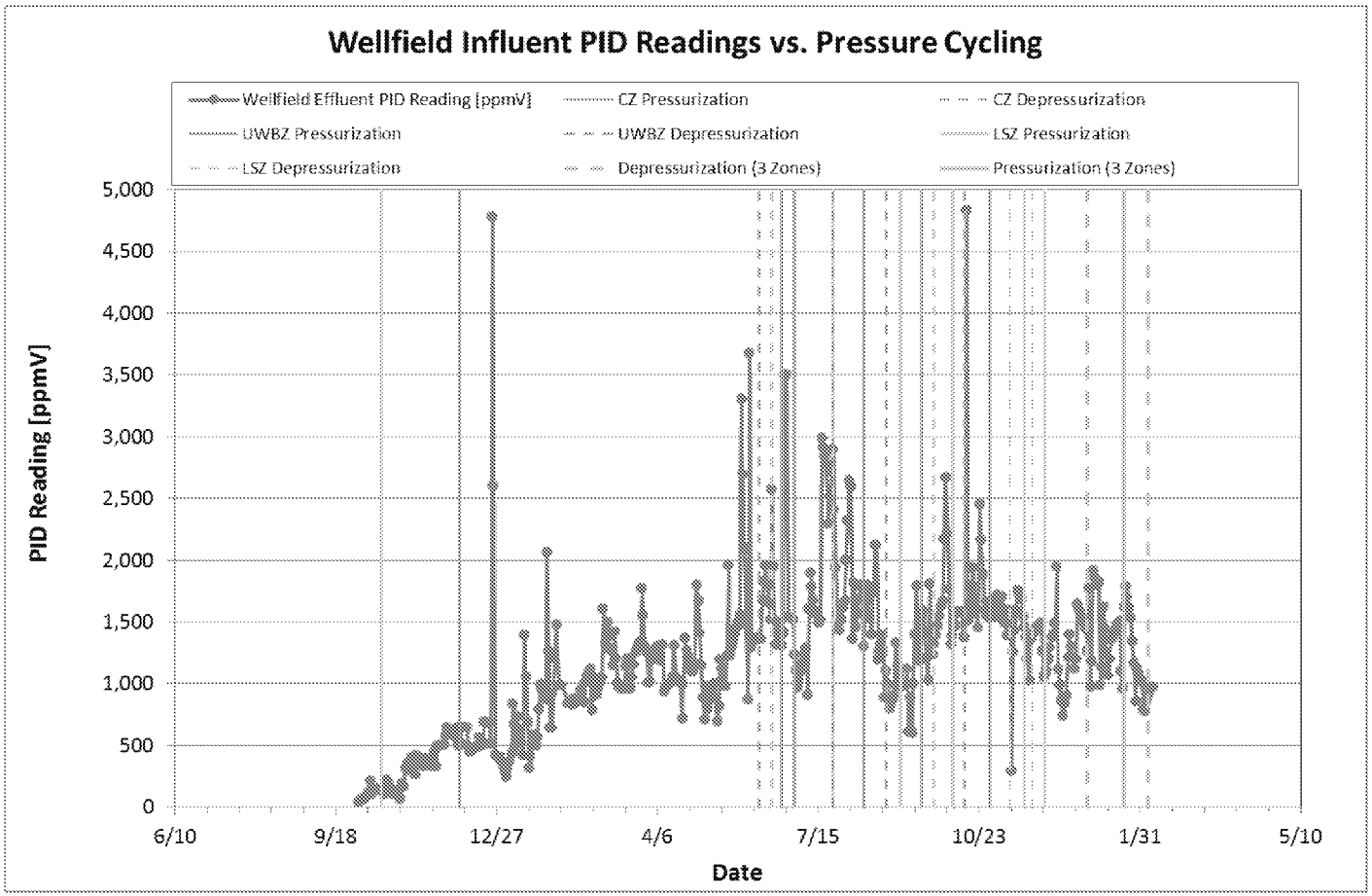
Mass Removal over Time



- **Peak mass removal occurred April – June 2015 (vapor and NAPL phases)**

Pressure Cycling and Vapor Concentrations Over Time

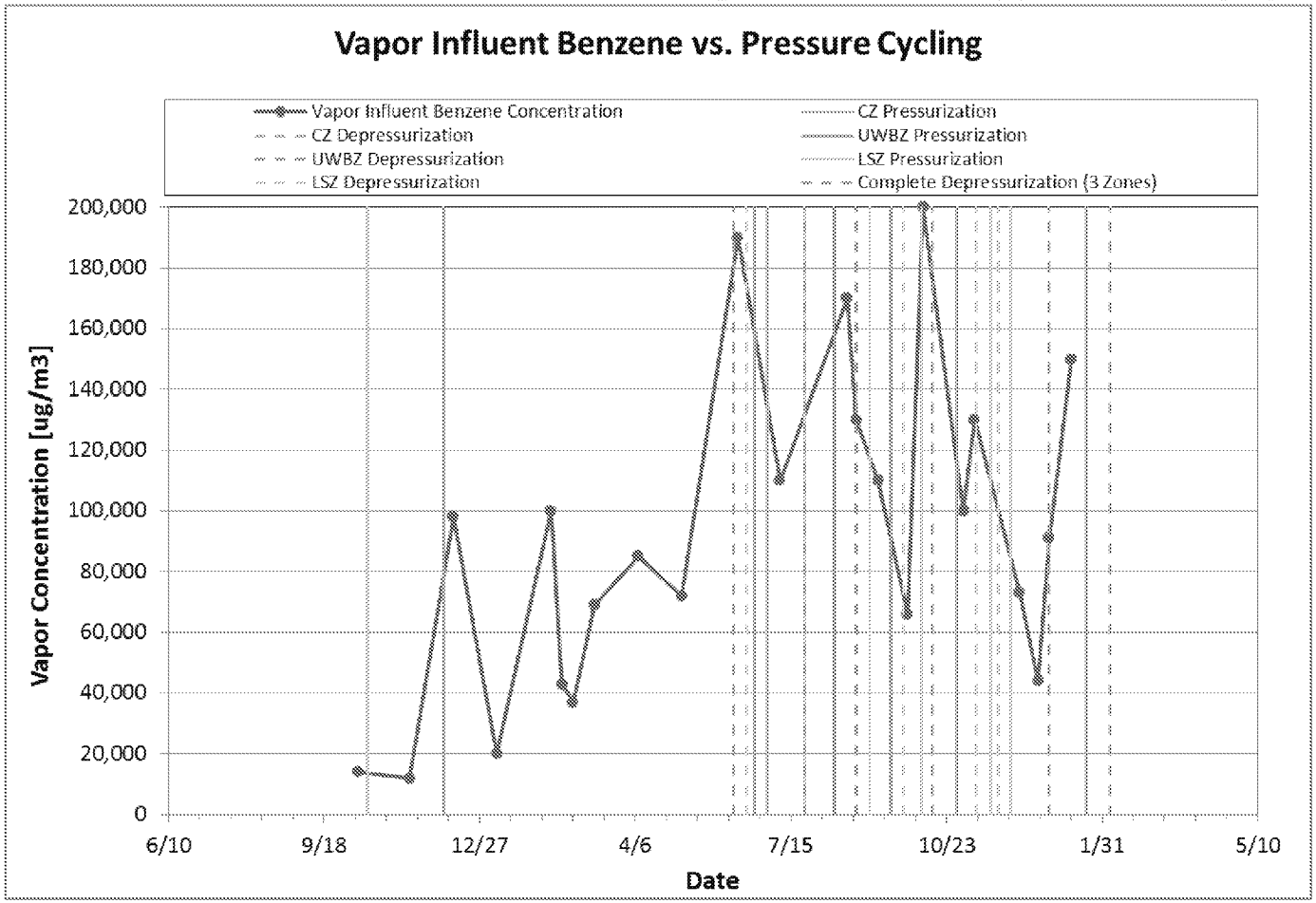
Wellfield Vapor Influent PID Concentrations over Time



- **Vapor phase removal decreased during the site-wide pressurization**

Pressure Cycling and Benzene Vapor Concentrations Over Time

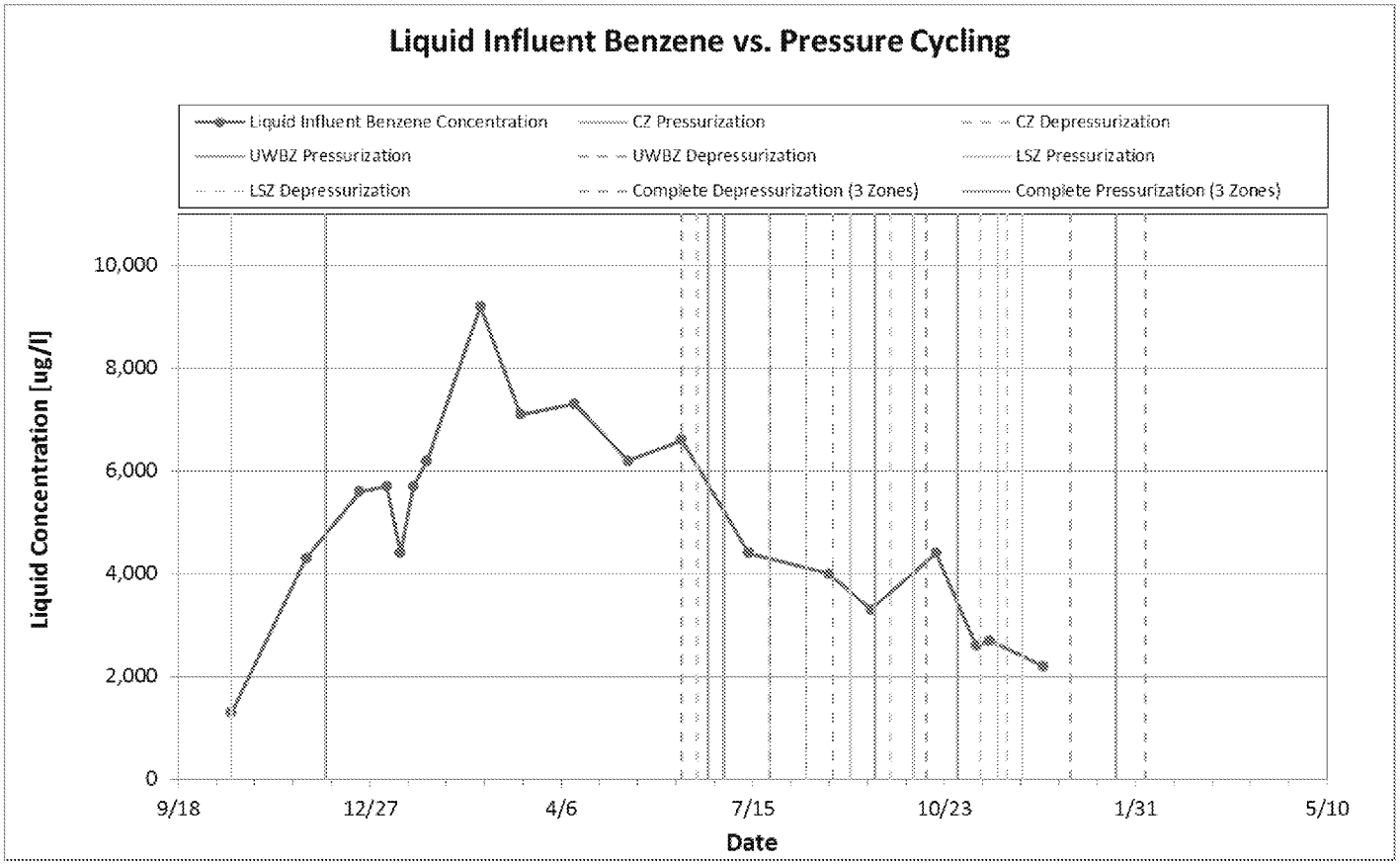
Extracted Vapor Benzene Concentrations over Time
(measured at thermal accelerator influent [includes air stripper effluent] by EPA Method TO-15)



- **Benzene concentrations have fluctuated during pressure cycling**

Pressure Cycling and Benzene Liquid Concentration Over Time

Extracted Liquid Benzene Concentrations over Time (measured at air stripper influent by EPA Method 8260B)



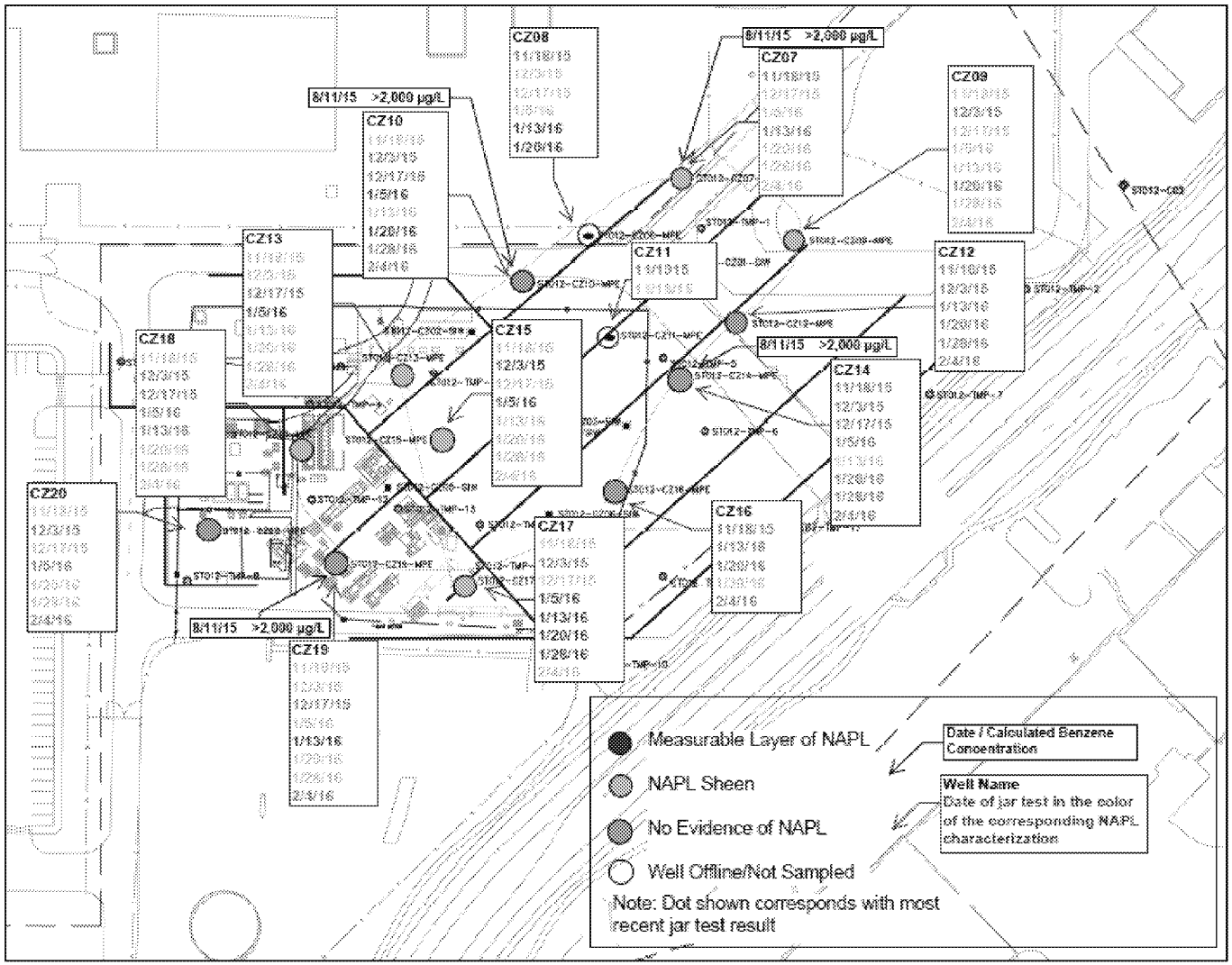
- **Benzene concentrations have declined**

Benzene Concentrations in Groundwater and NAPL Delineation

Site ST012 SEE System Benzene Concentrations

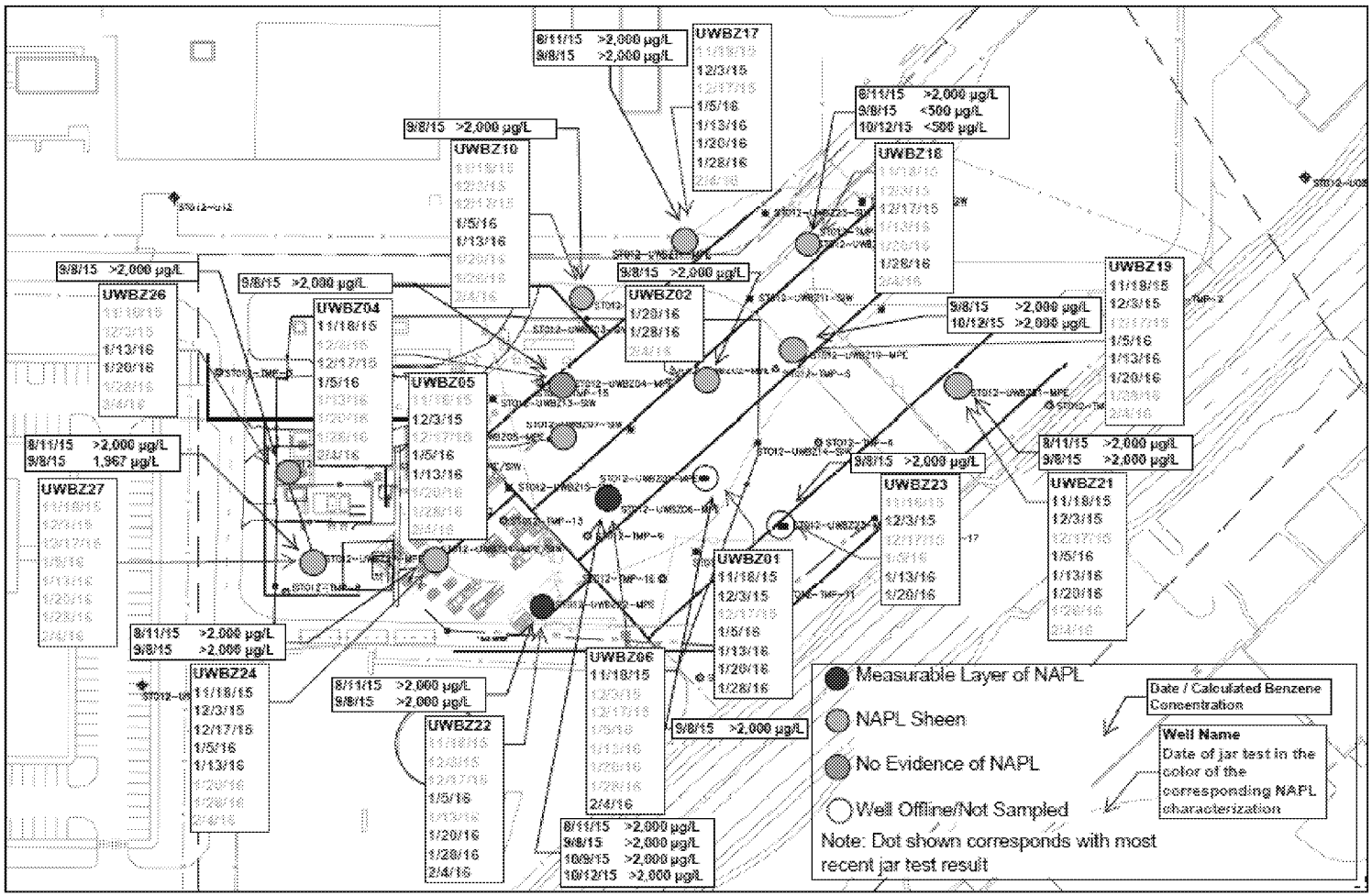
- 100 to 500 µg/L was set as the goal for SEE in the interior as the concentration range where natural attenuation can complete complete degradation within the remedy timeframe (20 years post ROD)
- Groundwater concentrations above 500 µg/L expected to remain at TTZ perimeters because of known contamination outside of TTZ.
- Contribution from perimeter likely enhanced by elevated temperatures (increased dissolution and solubility)
- Groundwater concentrations may also be above 500 µg/L in some areas of TTZ interior because of contribution from perimeter groundwater (i.e., extracted groundwater at interior MPE wells originates as a combination of condensed steam and perimeter groundwater that has pulled to the interior)
- Concentrations above 500 µg/L (as high as 5,500 µg/L in RD/RAWP model) in the TTZ can be addressed through EBR
  - Depletion of LNAPL in TTZ interior leaves mainly dissolved phase BETX
  - Sulfate injected at perimeter will migrate and contribute to reductions in TTZ interior
  - EBR treatment of perimeters will reduce further perimeter contributions to TTZ interior
  - Additional sulfate can be injected in TTZ if necessary

NAPL Screening Results and Calculated Benzene Concentrations – Cobble Zone August 2015 – February 2016



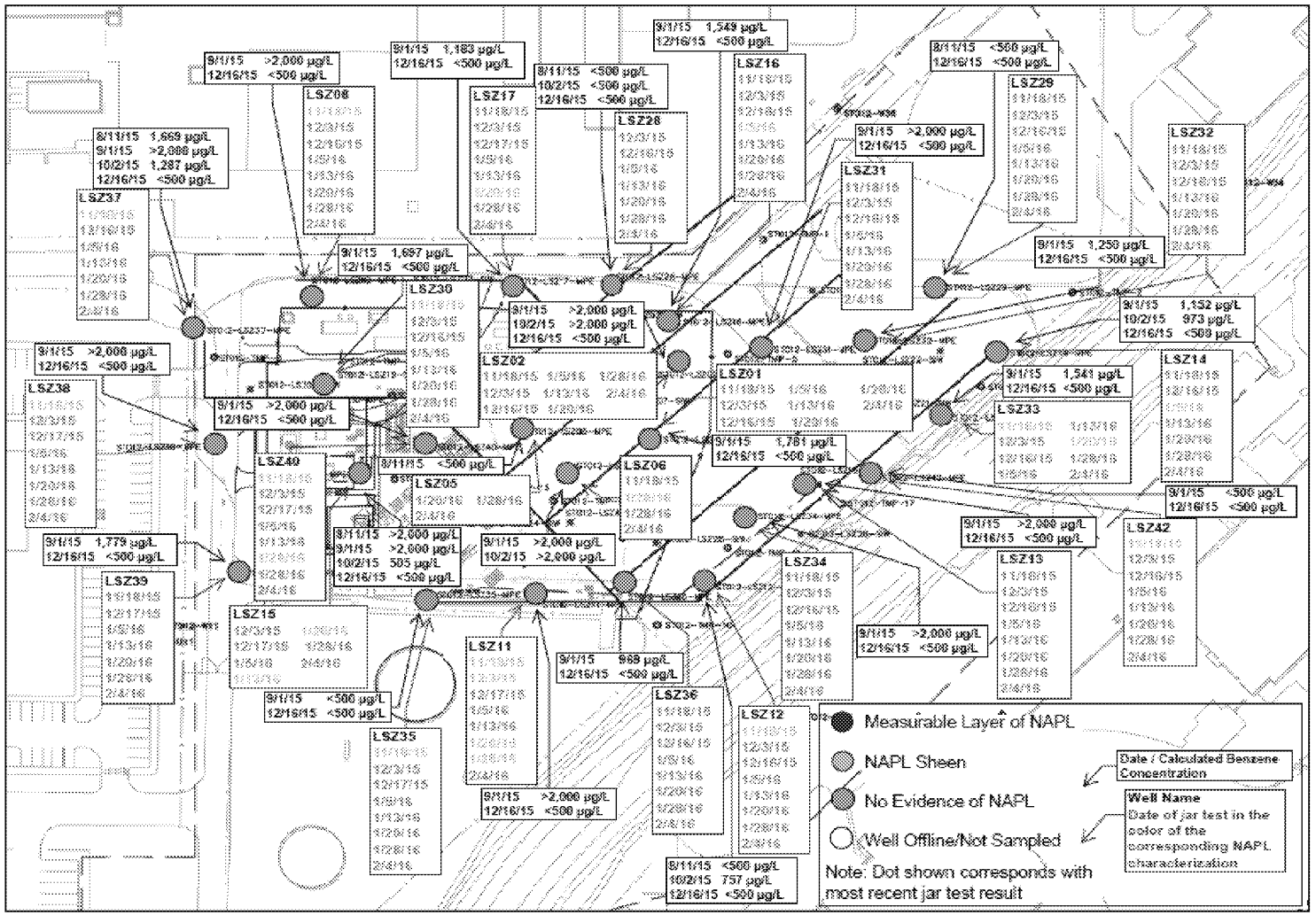
- Site wide pressurization initiated 21 January 2016
- Site wide depressurization initiated 05 February 2016
- NAPL screening results showed decrease in measurable layers of NAPL and NAPL sheens post-pressurization

NAPL Screening Results and Calculated Benzene Concentrations – Upper Water Bearing Zone August 2015 – February 2016



- Site wide pressurization initiated 21 January 2016
- Site wide depressurization initiated 05 February 2016
- NAPL screening results showed increase in measurable layers of NAPL and NAPL sheens post-depressurization

NAPL Screening Results and Calculated Benzene Concentrations – Lower Saturated Zone August 2015 – February 2016



- Calculated benzene concentrations <500 µg/L at all locations for 16 Dec 2015 event
- Site wide pressurization initiated 21 January 2016
- Site wide depressurization initiated 05 February 2016
- NAPL screening results show no increase in measurable layers of NAPL

Integrity - Service - Excellence

SEE to EBR Transition Criteria Summary

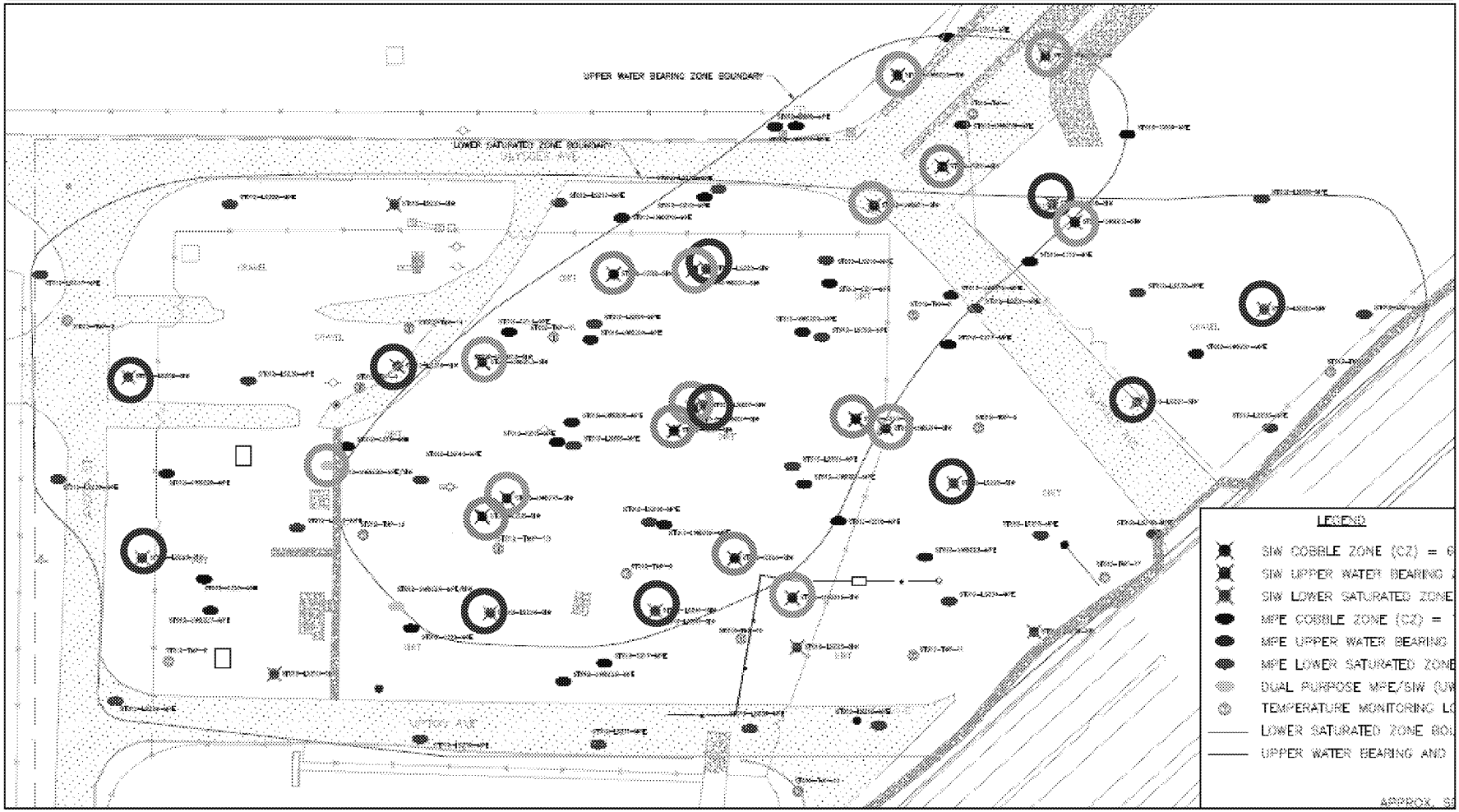
Site ST012 SEE System
SEE to EBR Transition Criteria Progress

Transition Criteria	Progress
Target Temperature Achievement	• CZ: Average target temperature achieved • UWBZ: Average target temperature achieved • LSZ: Average temperature achieved (depths above 235 ft bgs) • Steam breakthrough observed at all interior MPE wells
Pressure Cycling Status	• CZ: Currently in the sixth pressurization/depressurization cycle • UWBZ: Currently in the eighth pressurization/depressurization cycle • LSZ: Currently in the eighth pressurization/depressurization cycle
Mass Removal Status	• Peak mass removal occurred April – June 2015 (vapor and NAPL phases) • Significant increase in NAPL production during site-wide depressurization, NAPL production decreased during site-wide pressurization • Mass removal approaching target
Benzene Concentrations	• Benzene concentration target achieved in the LSZ • NAPL production still evident in CZ and UWBZ so benzene target not likely reached, groundwater sampling results pending. Perimeter NAPL contribution may be limiting progress.
Steam Injection Status (guideline)	• 296.6 MM lbs injected versus 320 MM operations guide – lower permeability zones accepting less steam than modeled. • Achieved flushing of 1.7 pore volume (1.5 pore volume design) – not a NAPL depletion design but a benzene reduction design, thus less than 2 pore volumes seen at other sites • Steam quantity or pore volume flush not a major metric – benzene content in TTZ is (driving polishing phase)

Site ST012 SEE System Path Forward

- Primary transition criteria met for LSZ (temperatures and mass removal). Approaching criteria in UWBZ and CZ. Pressure cycling currently ongoing in all three zones.
- Steam injection in the perimeter LSZ wells has been discontinued – maintain interior LSZ steam injection to facilitate heating in the UWBZ
- Coordinated pressure cycle ongoing (all zones simultaneously)
- Sampling/cycling frequency:
  - Continue ~weekly NAPL screening results
  - Groundwater samples have been collected in the UWBZ and CZ (results pending)
  - Currently in a site-wide depressurization
  - Site-wide pressurization to begin mid-February
  - Shutdown of steam – end of February
  - Post steam extraction to begin in Mar 2016
- Sample frequency is dynamic in response to results received at each round.
- The discharge non-compliance will continue to be investigated and corrective actions implemented

Site ST012 Steam Injection Strategy Path Forward



LSZ wells online (11)

UWBZ wells online (11)

CZ wells online (6)

Response to EPA Comments on EBR RD/RAWP Addendum #2

Response to ST012 EBR EPA Comments

Continuation of SEE for Significant Mass and Mobilized LNAPL Removal

- **The RD/RAWP establishes the criteria for termination of SEE and transition to EBR**
- **Mass removal and mobilized LNAPL removal is primarily due to migration from outside the TTZ**
- **Continued steam injection is not efficient for mobilization of mass from outside the TTZ**
- **End steam injection in Feb 2016 and focus on post steam extraction period**
- **Operate post steam extraction as per RD/RAWP or until LNAPL removal has diminished**

Response to ST012 EBR EPA Comments

LNAPL Should be Further Characterized Prior to Finalizing EBR

- **LNAPL extent is understood but uncertainty does exist in areas targeted for EBR**
- **Full characterization is not necessary, to begin EBR with a phased implementation approach**
  - **Phased approach has been successful in understanding LNAPL extent**
    - **PDI**
    - **Full-scale drilling**
  - **LNAPL extent will continue to be refined with phase 1 EBR drilling**
  - **Additional characterization will be evaluated based on phase 1 EBR data**
- **Characterization of LNAPL prior to final EBR design would delay EBR implementation**
  - **Would jeopardize progress toward 20-year timeframe in Record of Decision**
  - **Not consistent with ADEQ request to accelerate site cleanup**

Response to ST012 EBR EPA Comments

Addendum is Scaled Back from RD/RAWP

- **The RD/RAWP presented a conceptual design to demonstrate a proof of concept for EBR to address remaining contamination following SEE treatment**
- **Addendum 2 design refines the EBR conceptual approach**
  - **Updated understanding of LNAPL distribution, refinement of operational challenges**
  - **Batch injections with interior extraction instead of recirculation**
    - **Overcomes logistics of recirculation system across Sossaman and neighboring active properties**
  - **Phased implementation instead of full scale implementation**
    - **Start injection/extractions in most impacted areas (Phase 1)**
    - **Adjust injection/extractions based on drilling and monitoring (Phase 2+)**
    - **Start implementation with partial theoretical sulfate demand (Phase 1)**
      - **Sulfate for full degradation of LNAPL not required (BETX+N COC focus)**
      - **Lower molecular weight (MW) COCs will degrade faster than some of the higher MW JP-4 components**
      - **Reduce risk of overdosing sulfate**
      - **Add more sulfate when supported by the data (Phase 2+)**

Response to ST012 EBR EPA Comments

Differences Between RD/RAWP EBR and Addendum EBR

- **Top of UWBZ well screens**
  - **RD/RAWP specified 20 feet below CZ/UWBZ interface**
  - **Addendum uses 10 feet below interface based on success of SEE wells at this interface**
- **Extraction:Injection Ratio**
  - **Change in approach from recirculation to batch injections with extraction to promote distribution**
  - **Extraction:Injection ratio will far exceed the 1.4:1 indicated in RD/RAWP**
- **Sulfate Mass**
  - **5 pounds sulfate/pound JP-4 based on stoichiometry**
  - **7,600 tons sulfate based on stoichiometry and RDRA/WP JP-4 mass**
  - **Addendum uses 838 tons**
    - Full degradation of all JP-4 is not required to address COCs (BTEX+naphthalene)
    - Phased approach will allow for more efficient distribution of terminal electron acceptor

Response to ST012 EBR EPA Comments

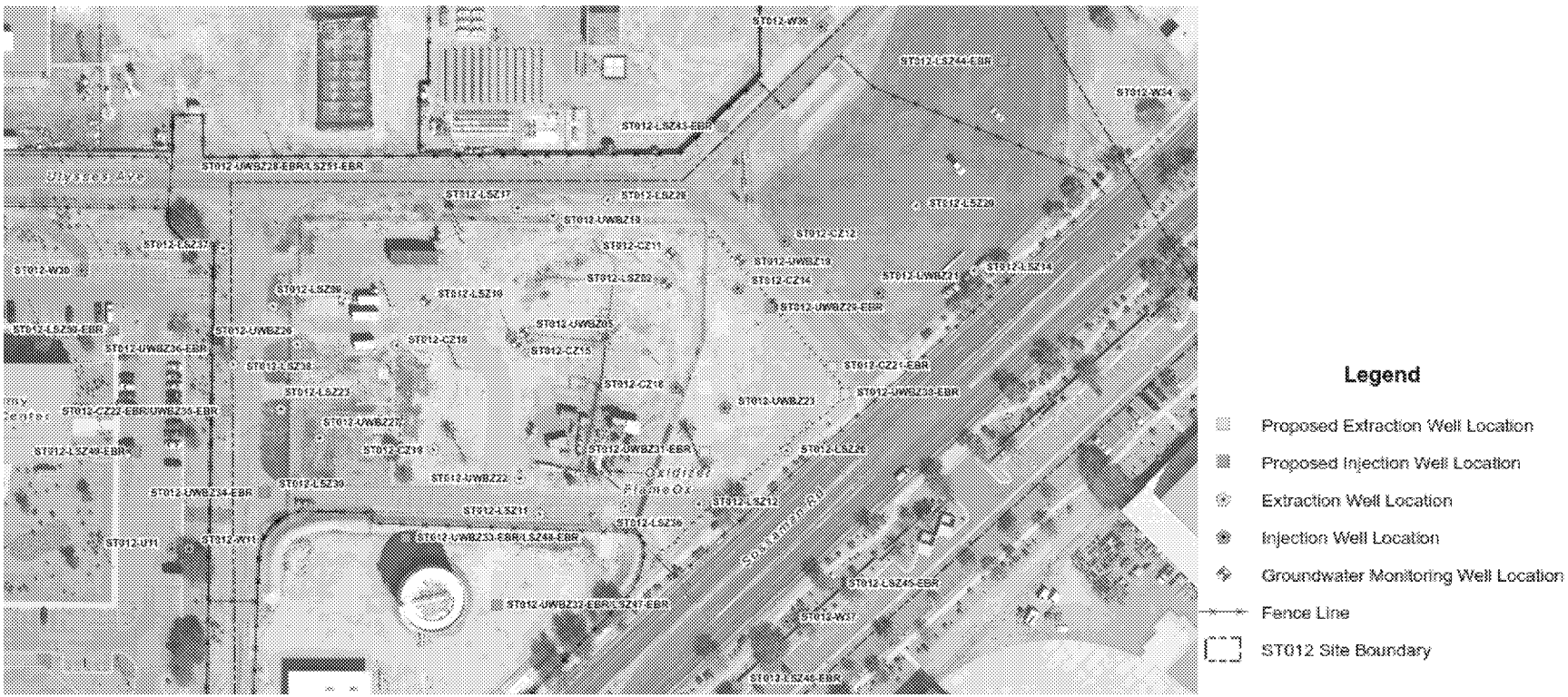
The Design is Only Conceptual In Nature

- **Addendum focused on a phased approach with flexibility similar to SEE and LF004 RD/RA instead of a prescriptive design**
- **Design details exist and can be included**
  - **TEA injection rates**
  - **Time sequence for injections to occur**
  - **Injection/extraction ratios**
  - **Predicted travel time of sulfate to extraction points**
  - **Tank sizes**
  - **Particle filtration and granular activated carbon systems**
  - **Controls/interlocks**
  - **Which injection wells will receive TEA solution via direct pumping, which require portable mixing tanks**
  - **Criteria to implement Phase 2 modifications**
- **Variations/modifications during implementation are to be expected based of field conditions and data evaluation**

Response to ST012 EBR EPA Comments

More Monitoring Wells for EBR (Separate from Inj/Ext Wells)

- **Sufficient monitoring well locations exist to fill in gaps where extraction wells do not provide coverage**
- **Additional SEE wells (separate from inj/ext wells) can be used as monitoring locations to extend lateral and vertical extent without installation of more wells**



Response to ST012 EBR EPA Comments

Modeling and Statistical Approaches Should Meet USEPA Data Quality Objectives

- **Current modeling in Addendum is guideline for phased design decisions**
- **The purpose of current modeling presented in Addendum was not to validate effectiveness of the overall design**
  - **Validation of EBR concept was presented in the RD/RAWP**
  - **Extensive modeling of Phase 1 and Phase 2 permutations at this time would not add significant insight to the EBR phased approach**
- **Future modeling incorporating operational data from Phase 1 and 2 will be used to validate completion at EBR to natural attenuation transition**
  - **Modeling will consider USEPA data quality objectives**
  - **Monitoring program would consider statistical approaches**

Response to ST012 EBR EPA Comments

Milestone Concentrations for EBR and MNA Should be Established

- **Milestone concentrations for the Phase 1 EBR can be presented**
- **Milestone concentrations for subsequent EBR and MNA phases will be presented upon development of the details for implementation of those phases (in BCT meetings or an additional RD/RAWP if necessary)**

Response to ST012 EBR EPA Comments

Contingency Measures for MNA Should be Established

- **Contingency measures for natural attenuation will be evaluated and presented at EBR to natural attenuation transitions (RD/RAWP addendum #3 or later)**